METHOD AND APPARATUS TO LOCATE LOST GOLF BALLS

The present invention relates to the location of lost objects, particularly though not exclusively lost golf balls.

During a game of golf it is common for a player, particularly a beginner, to loose a golf ball. This is undesirable, firstly due to the expense of replacing a large number of lost balls, and secondly, if a ball cannot be found, the player loses a stroke, which of course may result in loosing a game.

Several methods and devices have been devices to overcome this problem, by making golf balls easier to find. Generally these methods involve some kind of tagging of the balls, with the tag being easier to detect. For example US 6,482,108 McLaughlin teaches the use of a hologram applied to the golf ball and US 6,353,386 Castonguay teaches the use of odorous compounds. The disadvantage of these systems is that the player has to either adapt the ball by placing of the tag, or has to use specially developed balls.

Another method uses the fact that many golf balls are coated with whiteners that absorb light in the near-UV and fluoresce at a longer wavelength, generally in the blue part of the spectrum. Thus by shining UV light on the golf balls, they can be made to fluoresce and should be easier to detect. Devices are available commercially, which produce the relevant UV light. However, these devices are generally intended for use at night in order is discriminate the fluorescent emission from surrounding background light present during the day. In addition, as the light must shine directly onto the golf ball, the device must be operated in close proximity to the ball for any effect to be seen.

The object of the present invention is to provide an improved method and apparatus for locating lost objects.

According to the invention there is provided apparatus for detecting an object, the apparatus comprising:

- a light source adapted to emit a beam of light at wavelengths absorbed by the object or a coating thereon;
- a detector adapted to detect light at wavelengths fluoresced by the object or coating thereon; and
- a processor adapted to determine the presence of an object from the light detected by the detector.

Preferably the apparatus further includes an oscillator to modulate the light source. Typically this will be via a driver circuit.

Preferably the processor includes a mixer, which receives the modulation signal from the oscillator, and a signal from the detector. Typically the processor further includes a low-pass filter which is adapted to pass signals of a significant magnitude if a coherent signal averaged over time is present.

Advantageously, the processor will further include a threshold detector, which compares the signal from the low-pass filter with a predetermined threshold, and sends a signal to an indicator is the signal exceeds the threshold, to indicate the presence of a ball.

Generally the modulation will be in the frequency range 10 Hz to 100 MHz.

To help understanding of the invention, a specific embodiment thereof will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is a plan view of apparatus for detecting lost golf balls according to the invention; and

Figure 2 is a block diagram of the electrical components of Figure 1.

Referring to Figure 1, the apparatus thereshown includes an oscillator 101 which is adapted to produce a signal 102 that is used to modulate a light source 103. As shown the light source is a light-emitting diode (LED) although other sources could be used. The modulation may be sinusoidal or of other type, such as a square

wave, and may be an amplitude or phase modulation. The light source 103 produces a light beam 106 with emission in the blue or ultra violet (UV) part of the spectrum. The light beam is directed essentially forward of the light source at a wide angle. Depending on the light source, a lens or other optical system 104 may be used to direct, and widen the beam, and produce a desirable emission pattern.

Due to the coating applied to golf balls, the balls absorb light in the UV and blue range and re-emits (fluoresces) at a longer wavelength. The exact wavelength of the fluorescence depends upon the particularly coating applied to the ball, but generally a wavelength shift of several tens of nanometers is found.

Other material, such as grass, where a golf ball may be located, also fluoresce, but at a significantly lower efficiency, such that if fluorescence is detected it is likely to emanate from a golf ball.

The apparatus also includes a detector 109. The detector 109 is provided with a lens 108 that enables light from a wide angle to be collected by the detector. In addition, filters 110 are positioned in front of the detector in order to remove light of wavelengths other than that of the fluorescence anticipated from golf balls, and to allow as much of this light as possible to be received by the detector 109. In addition, since the fluorescence will be several orders of magnitude weaker than the light from the light source 103, light shields 111, 112 are placed around the light source 103 and/or detector 109.

The detector 109 sends the photo-current 114 to a processor 116 for determining when a golf ball is present. To aid in the processing of signals a copy of the oscillator signal 113 may also be input to the processor. If a ball is detected, a signal 115 is sent to an indicator 117 to alert a user to the presence of the ball.

The detector is sensitive to, and receives, only a small fraction of the light propagating in the direction of the detector. When detectors are not specifically designed to reject unwanted light, sunlight can easily overwhelm a detector rendering the device almost useless. For this reason, previous detectors have generally been for use at night and are effective only in very low ambient light levels. However, even

with the use of filters 110, sunlight can be strong enough in the relevant wavelengths, to overwhelm a weak fluorescent signal.

According to the present invention, synchronous detection is used to detect the week fluorescent signals from the golf balls, from the strong ambient light. Modulation is applied to the light source and to the detection circuit. As a result the signal is integrated coherently over the period of the modulation, T. Background light, however, has no specific phase relationship with the modulation. As a result the contribution of such light, or noise, to the signal detection does not build up linearly with time, but builds up as the square root of the period T. Thus, for a long enough integration time, the true signal will eventually outgrow the noise contribution and provide unambiguous detection.

The device will generally be used in a slow sweeping manner. Accordingly it is reasonable to assume that a signal integration time of the order of T = 01.s is reasonable. This corresponds to only admitting noise within a bandwidth B of approximately B = 1/T = 10 Hz.

Referring now to Figure 2, which shows the implementation of synchronous detection. An oscillator 201 applies a modulation 202 to a driver circuit 203 that in turn provides a drive signal to LED 204 and simultaneously sends the modulation signal 205 to a mixer 206. The frequency of the modulating signal is not critically import and may lie in the range from 10 Hz to 100 MHz. Output light 207 is converted to fluorescence 208 by a golf ball or the like that is received by detector 209, sent (210) to amplifier 211 and from then sent 212 to the other input port of mixer 206. The output 213 of mixer 206 is send to low-pass filter (LPF) 214. The filter is designed to cut off frequencies above a designed bandwidth B and therefore only passes signals of significant magnitude if a coherent signal averaged over a time T = 1/B is present. The output 215 of the LPF is passed to a threshold detector 216 that compares the LPF signal to a predetermined threshold. If the signal exceeds the predetermined threshold then a signal 217 is sent to an indicator 218 to indicate the presence of a ball.

The invention is not intended to be restricted to the details of the above-described embodiment. For instance, multiple light sources may be used, or example arranged in a hexagonal pattern, to increase the light power applied to the golf ball. In addition, the light source may be modulated at high frequency such as 10-100MHz so that detection of the received signal phase relative to the applied modulation phase can be used to also determine the distance to the ball. Finally the device can be constructed using plastic lenses for the options, including plastic Fresnel lenses.